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OBSERVATIONS ON SOME COPEPODA THAT LIVE AS MESSMATES OR COMMENSALS WITH ASCIDIANS.

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(*Read Feb. 27, 1907.*)

In two previous papers read before this Society — one in January 1903 and the other in March 1905—I referred to a number of Copepoda which, in one way or another, are associated with fishes and with various marine invertebrates, as parasites, messmates, or commensals. In these papers I have shown that, in addition to fishes,—all of which now and then become, *nolens volens,* the hosts or entertainers of many kinds of Copepoda,—such organisms as Sponges, Echinoderms, Annelids, Crustacea, and Mollusca are also called upon to provide food and shelter for not a few of those guests which, in almost every case, may be correctly described as "uninvited."

As no special mention was made in my two last papers of the messmates of the Tunicata, my observations in this third paper will be confined chiefly to some of those Copepoda that are known to live in the company, and under the shelter and protection, of various kinds of Ascidians. To judge from the number of the organisms sometimes found located upon and within the test of one of the larger Ascidians or Tunicates, one might be led to imagine that the other invertebrata considered the test of an Ascidian to be common property, and had proceeded to carry out the socialistic idea, as far as they could, to its logical conclusion by taking forceful possession both of the outside and inside of the Ascidian's dwelling,—a dwelling which it had built up by its own exertions and for its own convenience.

Among the trespassers upon the preserves of the Tunicata is the *Modiolaria marmorata.* This dainty mollusc may frequently be found embedded in the tests of the larger Ascidians, such as, for example, *Ascidia* (*Phallusia*) *mentula*

O. F. Müller. It is sometimes buried so deeply in the substance of the test as to be almost entirely concealed, and where it can only communicate with the outside world by means of a small passage having an opening on the outer surface. Dr J. Gwyn Jeffreys, referring to this mollusc, remarks that sometimes a score of specimens may be extracted from a single large Ascidian. I have also found in cells formed in the tests of Ascidians several specimens of the curious little Amphipod, *Tritœta gibbosa;* while zoophytes of several kinds have been seen adhering to various other parts of its surface.

But if, having finished the examination of the outside of the test, we proceed to investigate the inside of it, perhaps the first of the objects to be observed will be one or two specimens of *Leucothoë spinicarpa* Abildgaard—a moderately large, soft-bodied, and sluggish Amphipod of a pale flesh colour, and bearing green-coloured ova. Then there are nearly always present in the branchial chamber a number of Copepoda which may belong to several distinct species, and thus it sometimes happens that the capture of a large Ascidian may turn out to be a miniature treasure-house to the marine zoologist.

The Copepod-messmates of Ascidians have had a good deal of attention devoted to them, especially by Continental zoologists, and the results of recent study seem to favour the opinion that in development and structure they exhibit a more or less near relationship with *Cyclops.* But this relationship, though obvious in some cases, is obscure in others. There are, for example, a few species that resemble *Cyclops* somewhat closely, both in their general appearance and habits. Like *Cyclops,* they carry two external ovisacs; they are active in their movements, gliding freely and quickly over the walls of the branchial chamber. These forms belong to the Lichomolgidæ, and their affinity with *Cyclops* is so evident that they have been classified along with that group and some other Copepoda in the division Cyclopoida. It may be observed in passing that while there are Lichomolgi which pass their lives as the messmates of these Ascidians, there are other species belonging to the same genus that live a free life amid the forests of Laminaria and zoophytes which in some places fringe our shores, and it has been suggested that the forms which now seek the shelter and protection of the Ascidians were formerly as free-living as the others.

But though these Lichomolgi and a few other species have retained their active habits along with a certain amount of freedom within the branchial chamber of the larger Ascidians, the majority of the Copepoda found in such situations are usually inactive and sluggish in their movements, and have their limbs more or less imperfectly developed. Dr Brady, the eminent British authority on the Entomostraca, referring to these Copepoda, observes that they are indeed, in all probability, Cyclopidæ which have become modified in build by their inactive habits and the restricted boundaries of their dwellings; and it is evident that under these conditions the long antennæ and limbs of the free-swimming species would be an encumbrance, or at any rate be of very small service, and one would almost be inclined to believe that these appendages must still be in course of degradation, owing to constant disuse.

The Copepoda chiefly referred to in the foregoing remarks are those usually found within the comparatively roomy branchial chamber, but there are other species which hitherto have only been obtained in the alimentary tract, and are in consequence more restricted in their movements, and they also exhibit a rather more retrograde development. There also appears to be another and a rather interesting difference between a few of these forms whose environment is so limited and others that are favoured with a more liberal allowance of space. The females of the former species carry two external ovisacs, which are slender and sometimes considerably longer than the animal itself, as exemplified in *Aplostoma affinis* mentioned in my recently published 'Catalogue of Forth Crustacea.' On the other hand, the females of several of the species living in the more roomy branchial chamber are not furnished with external ovisacs, but have the fourth thoracic segment, with which the fifth is usually coalesced, enlarged on the dorsal aspect to form a pouch in which the ova are enclosed. This pouch when packed with ova becomes greatly distended, and forms a conspicuous part of the animal, owing to the colour of the developing eggs showing through the thin integument. It is because of this modification of the fourth thoracic segment that the name *Notodelphys* was given by Professor Allman to what is made the representative genus of Sars's division Notodelphyoida.

Having seen how closely these Copepoda are associated with the life and fortunes of the Tunicata, the question may be asked, What is likely to happen to the Copepoda should the Ascidian die? Dr Canu, speaking of some of the more active species, says that, on the death of their host, they are able to quit their shelter and proceed in quest of another Ascidian, and while doing so, move freely about on the bottom of the sea. But as they are seldom captured in this free-living condition, it can only be on rare occasions that they require to adopt this form of life.[1] Yet though the more active and lively species may be able to look after themselves in the manner described by Dr Canu, it is probable that not a few will share the fate of their host.

The alteration from a free-living to a semi-parasitic life has doubtless taken place long ago, seeing that the change of habitat has resulted in such a retrograde development as to cause the structure both of the body and its appendages to become so modified as to differ profoundly from that of the free-living species to which their ancestors appear to have been related. It is also interesting to find that in the early larval stages of even the most degraded forms they still retain some traces of their former free-living habits; and, moreover, it is during this early stage that such degraded forms usually seek for, and select, a suitable host, which, when selected, has henceforward to shelter and provide food for these unbidden guests.

The number of Copepod species that have been recorded as messmates of the Tunicata is considerable,—so much so, that I can claim only a limited acquaintance with them. The species of Tunicata which have been described as the hosts of these Copepoda are also fairly numerous, and include such large forms as *Ascidia mentula*—already referred to,—*Ciona intestinalis*, specimens of which have been obtained "measuring as much as a foot in length,"[2] and also the small *Cynthias, Styelas, Botryllus*, &c.

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[1] 'Les Copépodes du Boulonnais,' by Dr Eugene Canu, p. 187 (1892).

[2] 'Jour. Plymouth Marine Biol. Assoc.,' vol. vii. (N.S.), No. 2, p. 296 (Dec. 1904).

The Copepoda I now proceed briefly to describe may be arranged as follows :—

A. NOTODELPHYOIDA Sars.

1. Females provided with a single dorsal incubatory pouch in place of external ovisacs :—

Notodelphys Allman.
Agnathaner Canu.
Doropygus Thorell.
Notopterophorus O. G. Costa.
Doroixys Kerschner.
Bonnierilla Canu.
Gunenotophorus O. G. Costa.
Botachus Thorell.

2. Ovisacs, two, external, situated on the dorsal aspect, contiguous, and comparatively small, or situated laterally and more or less elongated :—

Ascidicola Thorell.
Botryllophilus Hesse.
Enterocola P. J. van Beneden.
Enteropsis Aurivillius.
Aplostoma Canu.

B. CYCLOPOIDA.

Lichomolgus Thorell.

In Lichomolgus the fourth pair of swimming-feet has the outer branches three-jointed, but the inner only two-jointed, and this forms one of the principal points of difference between it and other genera of the Lichomolgidæ. In *Pseudanthessius*, for example, the inner branches of the fourth pair consist of only one joint, while in *Herrmannella* they are three-jointed like the outer branches.

I shall now proceed to make a few observations on the better known species belonging to the various genera mentioned, and in the order in which they are given.

Genus Notodelphys.

Four species of Notodelphys have been recorded for the British Islands — viz., *Notodelphys Allmani*, *N. cœrulea*, *N. agilis*, and *N. prasina.* These have all been described by M. Thorell. The first-named appears to be the most common. I have obtained it in the Firth of Forth, in Loch Tarbert, and at Tarbert Bank at the mouth of Loch Fyne : indeed, whenever large and aged Ascidians are brought up in the dredge or trawl-net we nearly always find these Copepoda in the branchial chamber, and frequently other species as well. *Notodelphys Allmani,* besides being the most common, appears to be also the largest, of the various species. According to M. Thorell, they sometimes measure five millimetres in length, but the largest Scottish specimens I have noticed scarcely reach four millimetres. This form has long tail-segments, and the dorsal egg-pouch in the case of adult females is usually coloured and distended with ova, so that the specimens are conspicuous enough.

Notodelphys prasina is also of frequent occurrence, but it is not so common as the one just referred to. Though resembling that species in some respects, it is smaller, and is, besides, readily distinguished from it by the very short tail-segments. Rev. A. M. Norman, who collected this species at Oban, found it to be more abundant there than any other of the Entomostraca taken from the branchial sacs of *Ascidia mentula.* He has also recorded it as occurring in the same Ascidian in Shetland.[1] I have taken a number of specimens in large Ascidians dredged in East Loch Tarbert, Tarbert Bank, and Kilbrennan Sound, Firth of Clyde.

Notodelphys agilis is apparently less common than the others. Like *N. Allmani,* the tail-segments are elongated, and its appearance being otherwise somewhat similar to that species, the one might be easily mistaken for the other were it not that *N. agilis* is a distinctly smaller form. Dr Brady reports its occurrence off the coasts of Durham and Yorkshire, and at Shetland on the authority of Rev. A. M. Norman. I have obtained it very sparingly in the Firths of Forth and Clyde.

Notodelphys cœrulea.—Dr G. S. Brady states that this species differs scarcely at all from *Notodelphys Allmani,* and that he cannot find any good reason for separating it from that species.[2] He records it as having been obtained in *Corella* (*Ascidia*) *parallelogramma* and *Ascidia venosa.* I have not been able to identify this form among any of the Notodelphyidæ examined by me.

Other species of *Notodelphys* have been described as *Notodelphys elegans* Thorell, *rufescens* Thorell, and *tenera* Thorell, but none of these have so far been recognised as members of the British fauna.

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[1] 'British Copepoda,' by Dr G. S. Brady, vol. i. p. 132 (1879).

[2] Ibid., p. 130.

Genus AGNATHANER Canu.

Two species of *Agnathaner* have been recorded by Dr Canu in his work already referred to,[1] but as only the males have been described, the relative position of the genus is somewhat uncertain. One of the species, *Agnathaner typicus* Canu, was obtained in the branchial chamber of *Styelopsis grossularia* Van Beneden, and the other, *A. minutus* Canu, in *Circinalium concrescens* A. Giard. Neither of the two species has been observed in British waters.

Genus DOROPYGUS Thorell.

The Copepoda of this and other allied genera differ distinctly in appearance and habits from *Notodelphys*, and constitute the family Doropygidæ. In this group the cephalothorax is usually robust, and the posterio-dorsal sac with which the females are furnished is in adult specimens large and crowded with coloured ova: the colour varies to some extent, probably owing to the advancing development of the embryos. Several species of *Doropygus* have been described, and five at least belong to the British fauna. They require careful examination, however, as the specific characters are somewhat obscure, and are only reliable when dealing with mature specimens. All the species are moderately large, but I have not met with any British examples that reach the dimensions given by Continental authors. Though these creatures have robust bodies their legs are small, and, as might be expected, they are rather sluggish in their movements.

Doropygus pulex Thorell has been observed in large Ascidians dredged at various places, as off the coasts of Durham and Yorkshire, Shetland, Oban, and Loch Fyne. It has been obtained off Millport in *Ciona parallelogramma* by Alexander Gray, formerly of Millport Marine Station; and Dr Canu also gives the names of several species of Ascidians in which it has

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[1] 'Les Copépodes du Boulonnais,' p. 210.

been observed. Adult specimens measure fully two millimetres in length. The furcal segments are long and slender, and are about one-fourth of the entire length of the animal.

Doropygus auritus Thorell appears to be a moderately large species, reaching, in the case of adult females, to one-fifth of an inch in length. It has been recorded from Shetland by Rev. A. M. Norman, who obtained it in *Ascidia* (*Phallusia*) *mentula* O. F. Müller. This species differs from *D. pulex* in having very short tail-segments.

Doropygus Normani G. S. Brady is described as moderately common in large Ascidians. The length of adult females is stated by Dr Brady to be 3·3 millimetres. The tail-segments, though short, are distinctly longer than in the last species. This form has been obtained in the Firth of Forth off Musselburgh in the branchial chamber of large Ascidians (? *A. virginea* O. F. Müller).

Doropygus porcicauda G. S. Brady.—This species is not much inferior in size to *D. auritus*, the length of adult females described by Dr Brady being about four millimetres. It has been obtained in *Corella parallelogramma* dredged off the coast of Durham, and in large Ascidians dredged in Loch Fyne and at Birterbuy Bay, Ireland. I have taken what appears to be the same species in the Firth of Forth. This species, as implied by the name, is a robust form; the tail-segments are also moderately elongated.

Doropygus gibber Thorell has been recorded from Exmouth, from the pharyngeal cavity of *Ciona intestinalis*,[1] and Dr Canu describes it as very common in many of the Ascidians of the Boulogne littoral. The females of *D. gibber* are described as reaching to five and six millimetres in length. This species has been ascribed to the genus *Notopterophorus* by Giesbrecht and Canu, but as the wing-like dorsal expansions, which are apparently the chief distinguishing character of that genus, are entirely wanting, I have retained it in the genus to which it was originally assigned by M. Thorell.

Doropygus psyllus Thorell is a rare form, and has not yet been observed in British waters. I refer to it here because, according to Dr Brady, it seems to be very nearly allied to

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[1] "The Fauna of the Exe Estuary," by E. J. Allan and R. A. Tod, 'Jour. Plymouth Marine Biol. Assoc.,' vol. iv. (N.S.), No. 3, p. 325 (1902).

D. Normani. The maxillæ and foot-jaws, however, are apparently decidedly different in the two species. Canu records *D. psyllus* from *Ascidia virginea* and some other Ascidians.

Van Beneden, in his work on 'Animal Parasites,' divided these creatures into three groups—Messmates, Mutualists, and Parasites; and the Copepoda mentioned here under the Notodelphyoida he classified with the third,[1] but where he would place the others he does not say. I think, however, that they should all be arranged with the first group, the Messmates, for they do not appear to live on the tissues of their host, but are content to take a share of its food, or to live on the refuse matter in the branchial sac or digestive canal.

Genus NOTOPTEROPHORUS O. G. Costa.

The only species of Notopterophorus I have met with is that which I ascribed to *N. papilio* Hesse. It is a robust form, and is furnished with dorsal wing-like appendages entirely different from anything met with in other species, while if wanting in these appendages it would scarcely be recognised from a *Doropygus.* These wings, when perfect, taper off at the corners into long slender filaments, as may be seen in some of the specimens exhibited. *N. papilio,* though not the only species described, appears to be the one most common and widely distributed. I found it fairly plentiful in large Ascidians dredged in Scapa Flow in Orkney. It has also been obtained in East Loch Tarbert, Loch Fyne, at Oban, and the Shetland and Channel Islands. The appendages, which in some respects resemble the wings of a butterfly, but of course are not used in the same way, can, it is said, be moved with considerable energy, and Dr Brady's remark that the use of these appendages is at present quite unknown,[2] is apparently as applicable now as when it was published.

I may mention that the species I have here recorded as *N. papilio* Hesse appears to be much more robust than the drawings in the 'Monograph of British Copepoda' (Plate 31) represents that species to be, and therefore it is just possible that my specimens may belong to another species, but I scarcely think so.

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[1] 'The International Scientific Series,' vol. xx. p. 251 (1876).

[2] 'British Copepoda,' vol. i. p. 144 (1879).

A second species described by Buchholz under the name of *Notopterophorus elongatus* has been doubtfully recorded as British by Dr Brady, but none of my specimens agree with it. The largest of the specimens from Scapa Flow do not much exceed four millimetres in length.

Genus DOROIXYS Kerschner, and
Genus BONNIERILLA Canu.

These two genera, which are each represented by a single species,—*D. uncinatus* Kerschner and *B. longipes* (Kerschner),—do not appear to have yet been observed in British waters. They both have a general resemblance to species of *Doropygus*, and are found in similar situations. Dr Canu describes the first as very frequent in *Morchellium argus* M.-Edw., *Circinalium concrescens* Giard, and *Polyclinum luteum* Giard; and the other as very common in the branchial cavity of *Cynthia lurida* Thorell.

Genus GUNENOTOPHORUS O. G. Costa.

This genus, like the two last mentioned, is represented by only one species, *G. globularis* Costa, of which I have only seen a single specimen. This specimen was dredged near Sanda Island, at the mouth of the Firth of Clyde, in 1898, and is described and figured in Part III. of the 'Eighteenth Annual Report of the Fishery Board for Scotland' (p. 387, Plates 13 and 14). Dr Canu, who describes *G. globularis* as rare, says that it has been found in the branchial cavity of *Cynthia lurida* and a few other Ascidians.

Genus BOTACHUS Thorell.

The only species of *Botachus* which, up till the present time, appears to have been described is *B. cylindratus* Thorell. This species, unlike any of those previously referred to, is rather small, slender, and elongated. The average length of the specimens exhibited is about two millimetres. In nearly all those examined the abdomen is bent downwards, and forms a considerable angle with the thorax. The furcal joints are very short, and armed with hooked spines; the limbs are also short; while the ovigerous pouch, though of moderate length, is but slightly dilated. I found this species fairly common in large Ascidians dredged in Scapa Flow, Orkney, and I have also collected it in Loch Fyne. The Rev. A. M. Norman records it from the branchial sac and water-passages of *Ascidia mentula* collected at Shetland and Oban.

Genus ASCIDICOLA Thorell.

Ascidicola rosea Thorell is the only described species, and, like *Botachus cylindratus*, is elongated and slender, and might at a casual glance be mistaken for that species. But besides being at least twice as long as *Botachus*, *A. rosea* is furnished with two external ovisacs on the posterio-dorsal aspect of the thorax.[1] These ovisacs are at first contiguous, but later when the eggs have developed the ovisacs may become divaricate, as exemplified by some of the specimens now exhibited. I have obtained this species in Ascidians from Scapa Flow, Loch Fyne, and the Firth of Forth, but always sparingly. The Rev. A. M. Norman has found it in *Ascidia sordida* from Shetland, and in *Ascidia mentula* dredged at Oban and at Birterbuy Bay, Ireland, while Dr Brady has dredged it off the coast of Durham. Dr Brady gives the length of *Ascidicola rosea* as 5 mm., but those I have from Scapa Flow scarcely reach 4 mm. in length.

Genus BOTRYLLOPHILUS Hesse.

Several species of *Botryllophilus* have been described, but they may not be all distinct. They all appear to be somewhat rare, but that may be more apparent than real, for they are small species, and usually occur in the smaller Tunicates, such as *Botryllus* sp., *Distoma*, &c., which are more troublesome to examine than the larger Ascidians. The *Botryllophili* are readily distinguished from other Notodelphyoida by

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[1] "Les œufs pondus en sacs ovigères externes, sans abri dans cavité incubatrice close."—'Les Copépodes du Boulonnais,' p. 208.

the peculiar position of the fifth pair of thoracic feet in the female. This pair, each of which consists of a single, elongated, one-jointed branch, instead of being, like the preceding pairs, situated on the ventral aspect of the thorax, are each inserted on the fifth thoracic segment — one on each side, well round towards the dorsal surface—and project outwards in the form of prominent spine-like appendages. The ovisacs are external and contiguous, and together form a globular mass, which is situated on the dorsal aspect of the last thoracic segment, and between the two fifth feet.[1] It is fairly evident, from the peculiar and abnormal position occupied by the fifth pair of feet, that this remarkable arrangement has been brought about so that these appendages could protect the globular ovisac and hold it between them in its proper position, when otherwise it would have been easily displaced.

The few specimens I have obtained, and which I have doubtfully ascribed to Hesse's species *B. ruber*, were found in specimens of a *Botryllus* dredged in the Moray Firth, and also in Loch Fyne.

Genus ENTEROCOLA P. J. van Beneden.

Specimens of an *Enterocola* which I have doubtfully referred to *E. fulgens* van Beneden have on two occasions been dredged in the Firth of Clyde. They were found in the digestive canal (not the branchial cavity) of small Ascidians, the name of which I failed to obtain. All the specimens observed were females, and only one Copepod was noticed in each single Ascidian. The specimen seemed to occupy, to its full extent, that part of the canal where it occurred, and it was therefore somewhat difficult to remove the Copepod without displacing one or both ovisacs. The ovisacs,

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[1] In the 'Nineteenth Annual Report of the Fishery Board for Scotland,' Pt. III., p. 242, pl. xvii., figs. 15-27, I give a description and drawings of a female and a male. The female figure shows the relative positions of the fifth pair of feet and the globular ovisac. Hesse's figures of *Botryllophilus ruber*, while agreeing generally with the Moray Firth and Loch Fyne specimens, show the two ovisacs widely apart, one under each fifth foot,—thus presenting an arrangement that apparently has not been hitherto observed by any other author.

which are widely apart and vary in size in different specimens, are attached to the last thoracic segment: they extend along each side of the abdomen, and reach to some distance beyond its extremity. Each ovisac, which has its point of attachment to the thoracic segment protected by the short but broad fifth foot, contains a moderate number of fairly large ova. The body is cylindrical in form, and distinctly segmented. The thoracic limbs, as might be suspected from the confined habitat, are very short, and the animal itself appears to be sluggish. The ovisacs, which were of a red colour, were easily noticed through the semi-transparent integument of the digestive tube. Dr Canu says that he found the male of *E. fulgens* is frequent in spring-time and in September, while the female is common at all seasons in the digestive canal of *Polyclinum luteum* Giard.[1]

Genus ENTEROPSIS Aurivillius.

Very few species of *Enteropsis* have been described, and none of them, as far as I know, has been recorded from British waters, except that which I have described as *E. vararensis*.[2] They all seem to have a general resemblance to *Enterocola*, the female also being provided with two external ovisacs as in that genus. All the species appear to be moderately rare, and Dr Canu says that his *Enteropsis pilosus* was described from a single female obtained in the branchial sac of *Diazona hebridica* Forbes, one of the Social Ascidians.[3] Other two described species are *E. dubius* Schimkevitsch and *E. sphinx* Aurivillius.

Genus APLOSTOMA Canu.

Four female examples of a species belonging to Canu's genus *Aplostoma* were obtained in the alimentary canal of a species of Ascidia, identified doubtfully as *Ascidia* (*Ciona*) *intestinalis*. Only one specimen of the Copepoda was observed in each single Ascidian. The specimens were of a narrow cylindrical form, and the ovisacs they carried were slender and elongated, being about twice the length of the entire animal. They had a general resemblance to *Enterocola*, and were at first ascribed to that genus.[1] A more familiar acquaintance with these interesting Ascidian Copepoda, however, showed that they could not retain their position in van Beneden's genus, and that their true place was with the *Aplostoma* of Canu. They are closely allied to *Aplostoma brevicauda* Canu, but appear to differ in some minor details of structure: they have therefore been recorded under the name of *Aplostoma affinis*.[2] Dr Canu has obtained *A. brevicauda* in *Morchellium argus* M.-Edw., *Amarœcium Nordmanni* M.-Edw., and *Polyclinum luteum* Giard.

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[1] 'Les Copépods du Boulonnais,' p. 217.

[2] 'Nineteenth Annual Report Fishery Board for Scotland,' Pt. III., p. 241, pl. xvii., figs. 28-34.

[3] 'Les Copépodes du Boulonnais,' p. 220.

Genus LICHOMOLGUS Thorell.

Notwithstanding that there are numerous Copepoda included in the Cyclopoida, and also though not a few of them have been recorded as the semi-parasites or messmates of various other groups of invertebrates, scarcely half a dozen species—and all of them limited to the genus *Lichomolgus*, as that genus is at present defined—have been found among the different forms associated with the Tunicata.

Lichomolgus forficula Thorell appears to be the most common and generally distributed species, and it is scarcely ever found anywhere else than in the branchial sac of the larger Ascidians. This *Lichomolgus* is readily distinguished from its nearest allies by the two long tail-appendages: both of them are jointed near the middle, and this in itself is an innovation on what is usual among Copepoda. The species is small and of a whitish colour, and it is active in its movements, running with considerable agility over the surface of the branchial sac. I have found it moderately common in large Ascidians dredged in Scapa Flow, Orkney, and in the Clyde, but there does not seem to be any published record of its occurrence in the Firth of Forth. The Rev. A. M. Norman obtained it in *Ascidia mentula* dredged in Shetland: he has also found it at Oban, and at Plymouth in *Phallusia mamillata;* and Dr Brady records it from Mulroy Lough, Donegal.

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[1] "On some New or Rare Crustacea from the Firth of Forth," 'Ann. and Mag. Nat. Hist.' (6), vol. x. p. 203, pl. xvi., figs. 1-11 (1872).

[2] "Catalogue of Forth Crustacea," by T. Scott, 'Proc. Roy. Phys. Soc.,' vol. xvi. p. 363 (1906).

Lichomolgus furcillata Thorell has been obtained very sparingly in large Ascidians dredged in the Firth of Forth; and Dr Brady found the same species in the branchial sac of *Corella parallelogramma* sent to him from Shetland by the Rev. A. M. Norman, who has also dredged it near Eddystone Lighthouse. It is also recorded from Port Erin, Isle of Man, by the late I. C. Thompson, Liverpool.[1]

Lichomolgus albens Thorell.—I know of only two records of this species from British waters. The first in point of time is that published by the late I. C. Thompson, who found the species among algæ on rocks at Puffin Island off the coast of Anglesea;[2] the second mentions its occurrence in dredged material from Otter Spit, Loch Fyne;[3] but in neither case were the specimens found as messmates of Ascidians. Dr Canu, however, referring to this species, says: "Dans le Boulonnais je l'ai trouvée habitant la cavité péribranchiale et le cloaque de diverses Ascidies: *Ciona intestinalis* Mueller, *Molgula socialis* Alder, *Cynthia lurida* Thorell."

Lichomolgus Poucheti Canu, another species sometimes found associated with Ascidians, has not yet, so far as I know, been obtained in British waters. Dr Canu, the describer of the species, says that it is moderately rare, and that he found it in the Bay of Concarneau living as a semi-parasite with *Morchellium argus* and *Fragrarium areolatum*—two species belonging to that group of the Tunicata known as Social Ascidians.

And now, in bringing these observations to a close, I have only to add that though much still remains to be done among the semi-parasitic Copepoda of Scotland, not to speak of the British Islands, our knowledge of them is being gradually added to, and ere long, instead of forming a small portion of a general monograph, they may require a monograph all to themselves.

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[1] "Revised Report on the Copepoda of Liverpool Bay," 'Trans. Liverpool Biol. Soc.,' vol. vii. p. 33 (1893).

[2] Ibid.

[3] "Some Additions to the Invertebrate Fauna of Loch Fyne," by T. Scott, 'Sixteenth Annual Report Fishery Board for Scotland,' Pt. III., p. 269 (1898).

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